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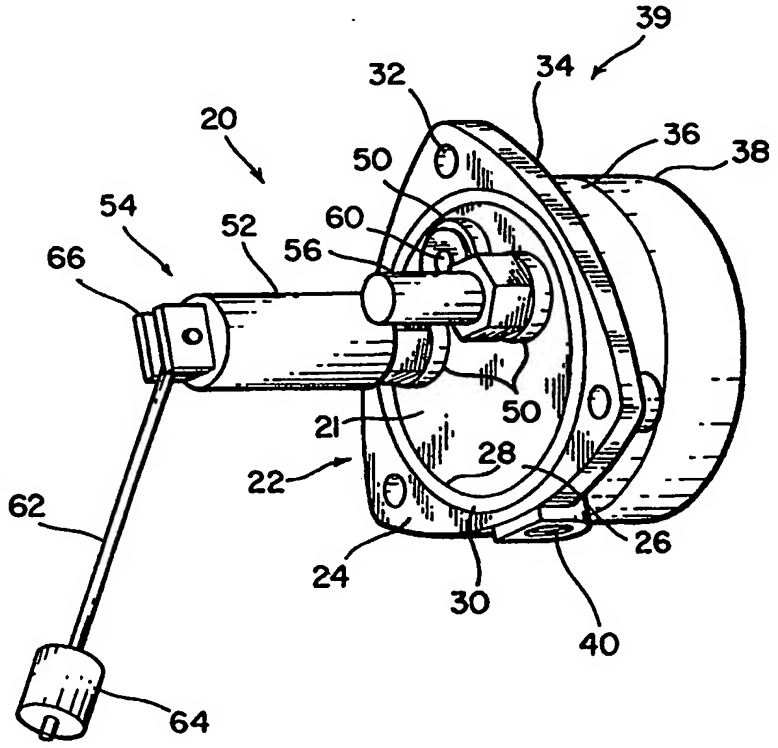
(54) Title: MULTIPLE SENSOR PLATE ASSEMBLY

(57) Abstract

A multiple sensor plate assembly (20) for use with an electrical power transformer (170) for sensing liquid level and at least one other parameter of the transformer (170). The assembly (20) includes a mounting plate (22) having a front surface (34) and a rear surface, and a plurality of instrumentation ports (50) in the mounting plate d22), at least one of which ports (50) is a liquid level port; a seal (30) on the rear surface of the mounting plate (22), surrounding the plurality of ports (50), for sealing the mounting plate (22) to a transformer (170); a liquid level sensor (54) mounted in the liquid level port; a housing (39) attached to the front surface (34) of the mounting plate (22); a liquid level gauge (70) attached to the housing (39) and connected to the liquid level sensor (54).



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MULTIPLE SENSOR PLATE ASSEMBLY

FIELD OF THE INVENTION

This invention relates to sensors for measuring operating parameters in oil filled power transformers and, in particular, to a multiple sensor plate assembly which includes an oil level sensor and one or more sensors for detecting oil temperature, winding temperature and pressure in a transformer and is mounted in a single opening of a vessel through which transformer oil is being circulated.

BACKGROUND OF THE INVENTION

Large power transformers in use today are cooled with oils to prevent premature aging and failure of the transformer components. Care must be taken to ensure that there is proper oil circulation, oil level is maintained and that the oil and windings do not overheat.

It is therefore necessary to keep a constant review of the oil temperature. Liquid temperature wells are used to measure the oil temperature along the outer wall of the transformer. However, they are not suitable for measuring temperatures of the transformer windings which are at high voltages with respect to ground. The temperature of the core winding can rise dangerously before the oil temperature changes are noted by the liquid temperature well on the transformer wall.

Winding temperature heater wells and winding temperature indicators have therefore been introduced. These devices simulate the amount of energy passing through the transformer at any particular time. An electric current, proportional to the load, is taken by means of a current transformer to heat and run through a resistor in the winding temperature heating well. The heat generated by the resistor is measured by a temperature sensing bulb on a temperature detecting device. The temperature of the winding temperature indicator is therefore increased above the surrounding oil temperature proportional to the load.

Once calibrated the winding temperature heater well can be used to simulate the winding temperature which, when combined with the oil temperature measured by the liquid temperature well, can accurately forecast dangerous overheating of the transformer.

US Patent RE. 31,685 describes a thermal plate device for measuring winding temperature and oil temperature in a transformer.

Thermal Plates, produced by QualiTROL Corporation, Fairport, N.Y. have a unit construction with combinations of winding temperature heater wells and liquid temperature wells on the same plate assembly. Such an assembly is mounted in an opening of the transformer. This eliminates the need for separate temperature sensing units mounted in separate ports found in earlier transformers.

In addition to temperature wells, oil cooled transformers are frequently equipped with an additional opening for an oil level sensor to ensure that the oil level is maintained. The oil level sensor is mounted through a separate opening in the transformer tank and coupled to an easy to read control gauge on the outside. Similarly, pressure sensors and pressure gauges to ensure that tank pressure is not exceeded may be mounted through yet another opening in the tank.

Such multiple openings can be a source of weakness and of leaks in a transformer and also increase the cost of manufacturing and installation of such transformers

Therefore, there is a need for a device having multiple sensors including at least one level sensor mounted on a single plate which is in turn mounted in a single opening of a transformer.

Furthermore there is a need for a multiple sensor plate which can be used to measure oil level and one or more of oil temperature, winding temperature and pressure in a transformer.

SUMMARY OF THE INVENTION

The present invention includes a multiple sensor plate assembly for an electrical power transformer for sensing liquid level, such as the cooling oil of an oil cooled transformer, and at least one other parameter of the transformer, the assembly including a mounting plate having a front surface and a rear surface, and a plurality of instrumentation ports in the mounting plate, at least one of which ports is a liquid level port; a seal on the rear surface of the mounting plate, surrounding the plurality of ports, for sealing the mounting plate to a transformer; a liquid level sensor mounted in the liquid level port; a housing attached to the front surface of the mounting plate; a liquid level gauge attached to the housing and connected to the liquid level sensor; and a sensor in another of the plurality

of ports having a connection passing through the housing to a remote monitoring device.

Another embodiment of the invention is a multiple sensor plate assembly for a vessel for sensing liquid level and at least one other parameter of the vessel, the assembly including a mounting plate having a front surface and a rear surface, and a plurality of instrumentation ports extending through the plate; a seal on the rear surface of the mounting plate, surrounding the plurality of ports, for sealing the mounting plate to a vessel; a tubular well having a closed end and an open end, the open end sealably attached to the rear surface of the plate in one of the plurality of instrumentation ports, for containing a temperature sensor; a support tube sealably attached to the rear surface of the plate in another of the plurality of instrumentation ports ; a liquid level sensor in the support tube; and a liquid level gauge coupled to the liquid level sensor.

Another embodiment of the invention is a combination of a transformer and a sensor plate assembly for an electrical power transformer for sensing liquid level and at least one other parameter of the transformer, in which the combination includes a mounting plate having a front surface and a rear surface, and a plurality of instrumentation ports in the mounting plate, at least one of which ports is a liquid level port; a liquid level sensor mounted in the liquid level port; a housing attached to the front surface of the mounting plate; a liquid level gauge attached to the housing and connected to the liquid level sensor; a sensor in another of the plurality of ports having a connection passing through the housing to a remote monitoring device; and a weld between the mounting plate and the transformer, surrounding the plurality of ports, for sealing the mounting plate to the transformer.

The novel aspects of this invention are set forth with particularity in the appended claims. The invention itself, together with further objects and advantages thereof may be more fully comprehended by reference to the following detailed description of a presently preferred embodiment of the invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a perspective view of a multiple sensor plate assembly.

Figure 2 is a partial cross sectional view of an oil level sensor and gauge.

Figure 3 is a perspective front view of the front of a multiple sensor plate assembly.

Figure 4 is a perspective rear view of the front of a multiple sensor plate assembly.

Figure 5 is a perspective view of a gauge housing for a multiple sensor plate assembly.

Figure 6 is a perspective front view of the front of another multiple sensor plate assembly.

Figure 7 is a perspective rear view of the front of another multiple sensor plate assembly.

Figure 8 is a perspective front view of a multiple sensor plate welded to a transformer.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Although the multiple sensor plate assembly of the invention is described with particular reference to its use with oil transformers it will be apparent to those with skill in the art that such an assembly is adaptable for use with other liquid containing vessels which need liquid level, liquid temperature and/ or pressure monitoring control systems, such as, for example, machinery, chemical reactors and storage vessels. Therefore, such other multiple sensor plate assemblies are contemplated by this invention.

Referring to Figures 1-7 preferred embodiments of a multiple sensor plate assembly are shown. Referring to Figure 1, a multiple sensor plate assembly 20 for use with oil filled transformers is disclosed. The assembly 20 has a plate 22 with a central portion 21 separated from a generally triangular-shaped mounting flange 24 by a circular groove 28 formed in the plate 22 and an O-ring sealing gasket 30 in the groove. Mounting holes 32 in the flange 24 allow the flange 24 to be bolted over an opening in the side of a tank containing circulating transformer oil. The assembly 20 is sealed to the tank by the gasket 30. A front surface 34 of the plate 22 is attached to a cylindrical wall 36 to which a removable cover 38 can be attached and sealed with a gasket. The housing 39 formed by the wall 36, the plate 22 and the cover 38 encloses a terminal block for

connecting to sensors which are attached to plate 22. A threaded connector 40 in the wall 36 allows electrical wiring to be lead into the housing 39 and connected to the terminal block. Electrical feedthroughs can also be provided in the thermal plate, which allows for the heater of a winding temperature heater well to be connected to a current transformer secondary leads within the transformer tank.

The plate assembly 20 can be mounted directly to the transformer tank or to the wall of a conservator tank through which the transformer oil is circulated and which is usually mounted on top of the transformer. The assembly is preferably mounted to the tank wall just below the minimum liquid level and above all heat sources so that the wells are exposed to a constant normal flow of liquid. The plate assembly can be mounted by bolts or by welding.

The central portion 21 of plate 22 is provided with a plurality of ports 50 extending through the plate to which a plurality of sensors can be sealably attached. In a first embodiment, as shown in Figure 1, there are three ports 50 in the plate to which are attached, a support tube 52 for an oil level sensor 54, an instrumentation tube 56 for a temperature sensor and a pressure sensor 60. It will be readily apparent that additional ports can be provided in the plate 22 for attaching additional sensors and that more than one sensor of the same type can be attached, as needed. The instrumentation tube, the support tube and the pressure sensor can be threaded at one end for screwing into tapped ports in the plate or they can be welded to the plate.

As shown in Figure 1, the oil level sensor 54 includes a float rod 62 and a float 64. The float rod 62 is connected to a bracket 66 which is coupled to a drive rod in the support tube and the drive rod is, in turn, coupled to a gauge. A direct reading gauge can be mounted to the cover 38.

Referring to Figure 2, for example, an oil level control gauge 70 relying on a magnetic operating principle can be used. The float 72, attached to a float rod 74, senses the oil level inside a tank and, as it moves up and down, turns a drive magnet 76 inside the support tube 78. The drive magnet 76 turns a follower magnet 80 attached to a pointer 82 in a dial assembly 84 *via* a magnetic coupling through a solid metal flange 86. The

movement of the pointer 82 can actuate switches 88 at preselected levels to provide a warning or operate equipment.. The float rod 74 is coupled to the drive magnet 76 by a drive rod 90, which is supported by brackets 92, 94 within the support tube 78, and a gear 96. The gear 96 rotatably connects the float rod 74 with the drive rod 90 and rotates the magnet 76. Alternative float sensors include those with a lever driven pointer and those in which the float rod is connected to a potentiometer which signals the oil level to a visual display unit.

The oil level sensor can be of any suitable type for mechanically or electrically sensing the oil level as the float moves up or down. Suitable liquid level devices are well known to those with skill in the art to which this invention pertains.

Referring to Figures 3 and 4, there is shown an alternative embodiment of a multiple sensor plate assembly 100 having an annular seal 101 and a circular flange 102 surrounding the central portion 104 of plate 105. Mounting holes 106 in the flange 102 mount the plate assembly 100 to a tank. As shown in Figure 3, the front surface 108 of the plate 105 has three ports 110 for holding different sensors. An annular groove 109 in the front surface 108 is provided for holding a gasket to seal with a cover. Referring to Figure 4, there is shown the rear surface 112 of the plate 105 with an oil level sensor 54 and tubular wells 114, 116 for temperature sensors. In a typical configuration one temperature well 114 is a liquid temperature well containing a temperature sensing bulb which is in turn connected to a temperature gauge, and the other temperature well 116 is a winding temperature heater well containing a heater element, a resistor element and a temperature sensing bulb which is in turn connected to a temperature gauge.

For visual indication of winding and liquid temperatures, the system requires dial thermometers or controllers to initiate control circuits for auxiliary cooling, alarm, trip devices or other equipment. The temperature sensing device may be either the bulb of a capillary type thermometer, or may be the resistor element of an electrical resistance temperature detector.

Suitable oil level sensors, temperature sensors and pressure sensors for use with the multiple sensor plate assembly of the invention are well

known and obtainable, for example, from QualiTROL Corporation of Fairport, New York.

Referring now to Figure 5, there is shown a multiple plate assembly cover 120 for housing an oil level gauge 122 and a terminal block 124. The pointer 126 of the oil level gauge is rotatably coupled to an oil level float. by a drive rod 128. The terminals 130 of the terminal block 124 can be wired to temperature level sensors contained in the instrumentation tubes or wells of a multiple sensor plate. Suitable temperature display units are then connected with the terminals 130. Access holes 132 in the rear of the cover 120 align with the ports in the multiple sensor plate which hold the sensors. Connector holes 134 allow electrical wiring to be lead into the housing 120 and connected to the terminal block 124. A window 136 in a door 138 of the housing 120 provides visual access to the oil level gauge 122. Displays for the temperature level sensors can be mounted to the door 138 or at remote locations.

Referring now to Figures 6 and 7, there is shown yet another embodiment of a multiple sensor plate assembly 150. Plate assembly 150 is essentially identical to plate assembly 100 of Figures 3 and 4 except that it has no mounting holes and is designed to be mounted to a transformer by welding. As shown in Figure 6, the plate assembly 150 incudes a plate 152 having a front surface 154 with three ports 156 for holding different sensors. An annular groove 158 in the front surface 154 separates a central portion 160 of plate 152 from a flange portion 162. The groove 158 holds a gasket for sealing with a cover. Referring to Figure 7, there is shown the rear surface 164 of plate 152 having an oil level sensor 54 and tubular wells 114, 116 for temperature sensors. Surface 164 is sealed with a transformer tank by forming a weld between the perimeter 166 of the plate 152 and the tank.

Referring to Figure 8, there is shown the plate 152 of plate assembly 150 sealed to a transformer tank 170 by forming a weld 172 around the perimeter 166 of plate 152 so that the weld 170 surrounds the ports 156.

Suitable materials for the components of the plate assembly include metals, such as steel, and non-magnetic metals such as brass, aluminum and zinc, and high density plastics.

The multiple sensor plate of the invention has unit construction with combinations of oil level sensor, liquid and winding temperature wells in the same assembly. Several operating parameters can be measured by a single assembly which can be mounted to a single opening of a tank. Thus, the number of sources of weakness and leaks in the transformer are reduced. Such a plate assembly permits the complete sealing of the oil inside the vessel from the gauges on the outside. This eliminates fire hazards, loss of product, incorrect level reading or equipment down-time due to leaking seals. The assembly permits removal of individual sensors or gauges in the field for repair or replacement without destroying the tank seal or lowering the liquid level below the gauge location. In addition costs associated with the manufacture of multiple units and their installation is obviated.

While the invention has been described in connection with a presently preferred embodiment thereof, those skilled in the art will recognize that many modifications and changes may be made therein without departing from the true spirit and scope of the invention, which accordingly is intended to be defined solely by the appended claims.

WHAT IS CLAIMED IS:

1. A sensor plate assembly for an electrical power transformer for sensing liquid level and at least one other parameter of the transformer comprising:

a mounting plate having a front surface and a rear surface, and a plurality of instrumentation ports in the mounting plate, at least one of which ports is a liquid level port;

a seal on the rear surface of the mounting plate, surrounding the plurality of ports, for sealing the mounting plate to a transformer;

a liquid level sensor mounted in the liquid level port;

a housing attached to the front surface of the mounting plate;

a liquid level gauge attached to the housing and connected to the liquid level sensor; and

a sensor in another of the plurality of ports having a connection passing through the housing to a remote monitoring device.

2. The sensor assembly of Claim 1, further comprising a flange surrounding the seal and a plurality of mounting holes in the flange.

3. The sensor assembly of Claim 1, further comprising an instrumentation tube attached to an instrumentation port of the mounting plate.

4. The sensor assembly of Claim 3, comprising a temperature sensing bulb in the instrumentation tube coupled to a temperature gauge for measuring a liquid temperature.

5. The sensor assembly of Claim 3, comprising a heater element, a resistor element and a temperature sensing bulb in the instrumentation tube coupled to a temperature gauge for measuring a winding temperature.

6. The sensor assembly of Claim 1, further comprising a pressure detector disposed in an instrumentation port of the mounting plate.

7. The sensor assembly of Claim 1, in which the liquid level sensor further comprises a support tube attached to the liquid level port, and first and second support brackets attached inside the support tube.

8. The assembly of Claim 7, in which the liquid level sensor further comprises a drive rod supported by the first and second brackets, a drive magnet at one end of the drive rod for magnetically coupling with the gauge, a float rod having a first end rotatably connected to an opposite end

of the drive rod, and a float fixedly attached to a second end of the float rod.

9. A multiple sensor plate assembly for a vessel for sensing liquid level and at least one other parameter of the vessel, the assembly comprising:

a mounting plate having a front surface and a rear surface, and a plurality of instrumentation ports extending through the plate;

a seal on the rear surface of the mounting plate, surrounding the plurality of ports, for sealing the mounting plate to a vessel;

a tubular well having a closed end and an open end, the open end sealably attached to the rear surface of the plate in one of the plurality of instrumentation ports, for containing a temperature sensor;

a support tube sealably attached to the rear surface of the plate in another of the plurality of instrumentation ports ;

a liquid level sensor in the support tube; and

a liquid level gauge coupled to the liquid level sensor.

10. The assembly of Claim 9, further comprising further comprising a flange surrounding the seal and a plurality of mounting holes in the flange.

11. The assembly of Claim 9, further comprising a housing attached to the front surface of the mounting plate for holding the liquid level gauge.

12. The assembly of Claim 9, further comprising a pressure detector in one of the instrumentation ports.

13. In combination with a transformer, a sensor plate assembly for an electrical power transformer for sensing liquid level and at least one other parameter of the transformer comprising:

a mounting plate having a front surface and a rear surface, and a plurality of instrumentation ports in the mounting plate, at least one of which ports is a liquid level port;

a liquid level sensor mounted in the liquid level port;

a housing attached to the front surface of the mounting plate;

a liquid level gauge attached to the housing and connected to the liquid level sensor;

a sensor in another of the plurality of ports having a connection passing through the housing to a remote monitoring device; and

a weld between the mounting plate and the transformer, surrounding the plurality of ports, for sealing the mounting plate to the transformer.

14. The sensor assembly of Claim 13, further comprising an instrumentation tube attached to an instrumentation port of the mounting plate.

15. The sensor assembly of Claim 14, comprising a temperature sensing bulb in the instrumentation tube coupled to a temperature gauge for measuring a liquid temperature.

16. The sensor assembly of Claim 14, comprising a heater element, a resistor element and a temperature sensing bulb in the instrumentation tube coupled to a temperature gauge for measuring a winding temperature.

17. The sensor assembly of Claim 13, further comprising a pressure detector disposed in an instrumentation port of the mounting plate.

18. In combination with a vessel, a sensor plate assembly for sensing liquid level and at least one other parameter of the vessel, the assembly comprising:

a mounting plate having a front surface and a rear surface, and a plurality of instrumentation ports extending through the plate;

a tubular well having a closed end and an open end, the open end sealably attached to the rear surface of the plate in one of the plurality of instrumentation ports, for containing a temperature sensor;

a support tube sealably attached to the rear surface of the plate in another of the plurality of instrumentation ports ;

a liquid level sensor in the support tube;

a liquid level gauge coupled to the liquid level sensor; and

a weld between the mounting plate and the vessel, surrounding the plurality of ports, for sealing the mounting plate to the vessel.

19. The assembly of Claim 18, further comprising a housing attached to the front surface of the mounting plate for holding the liquid level gauge.

20. The assembly of Claim 18, further comprising a pressure detector in one of the instrumentation ports.

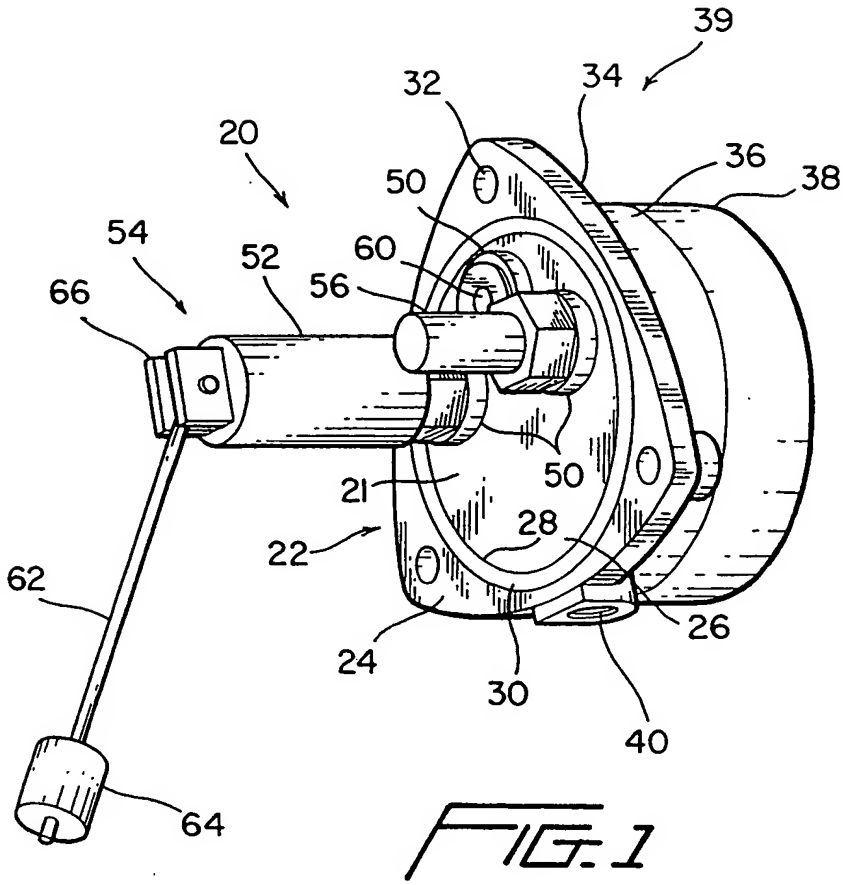
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FIG. 1

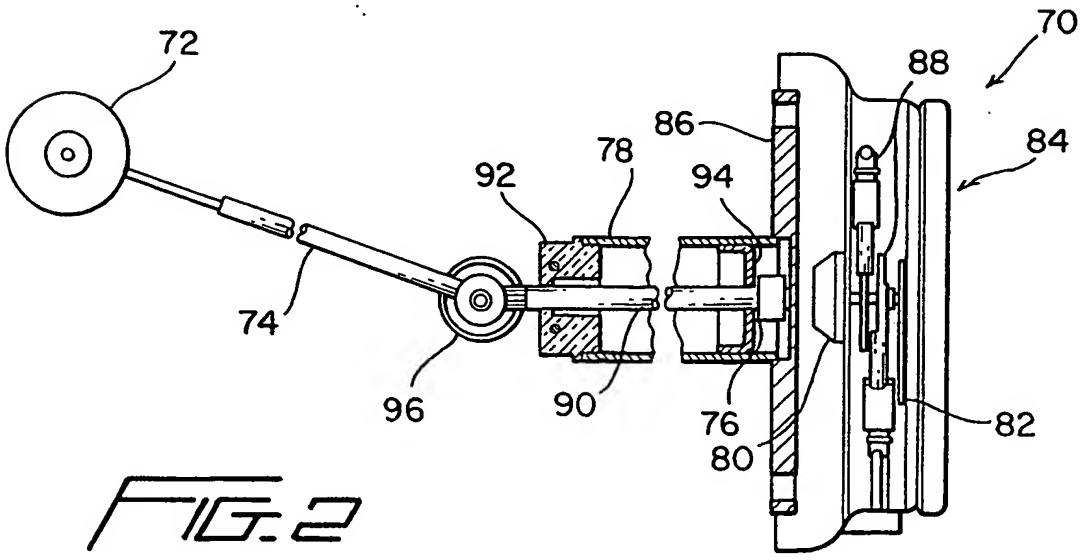
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FIG. 2

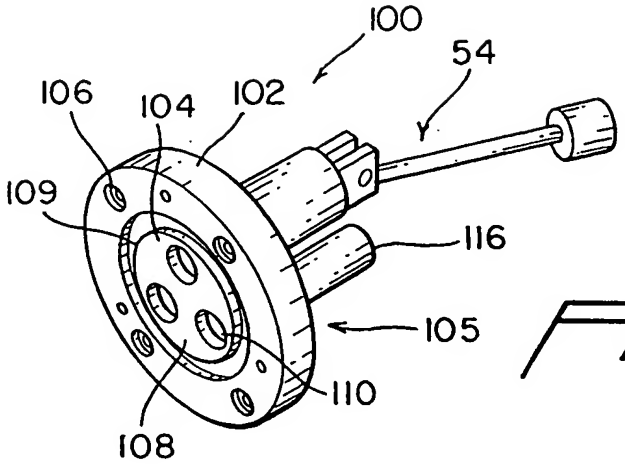

FIG. 3

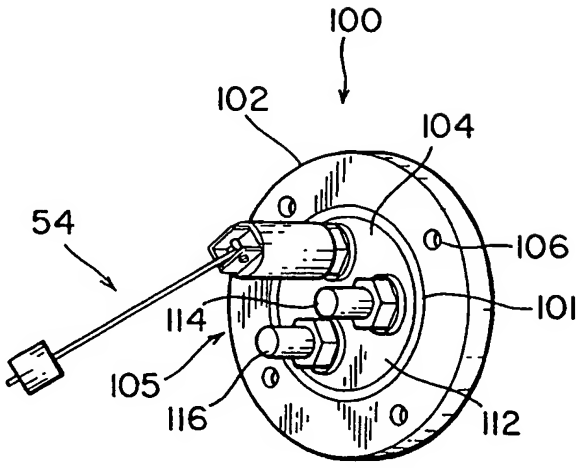

FIG. 4

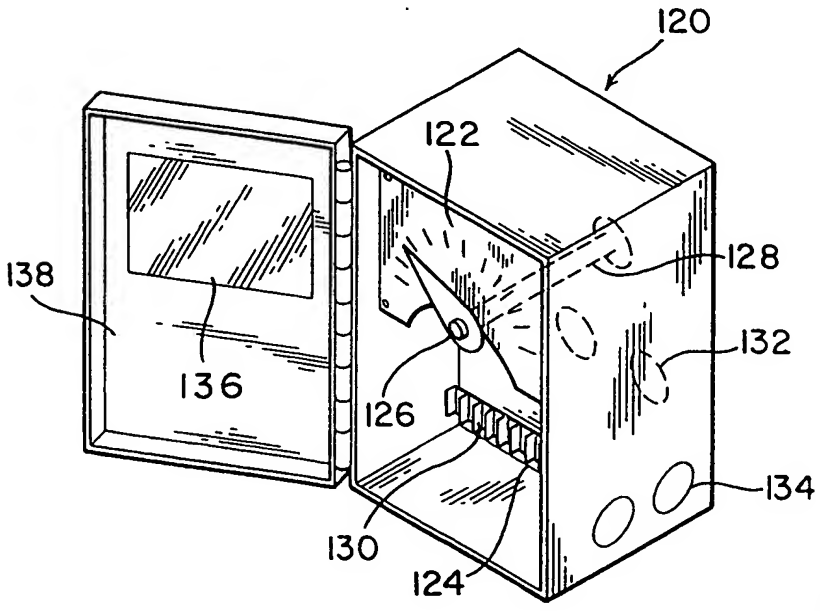

FIG. 5

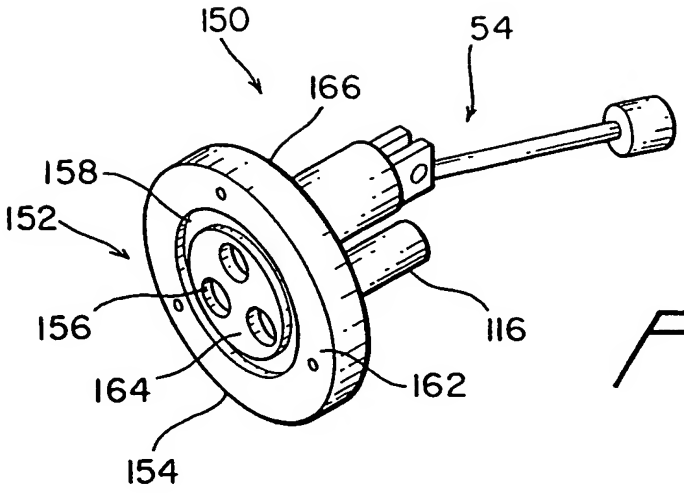

FIG. 6

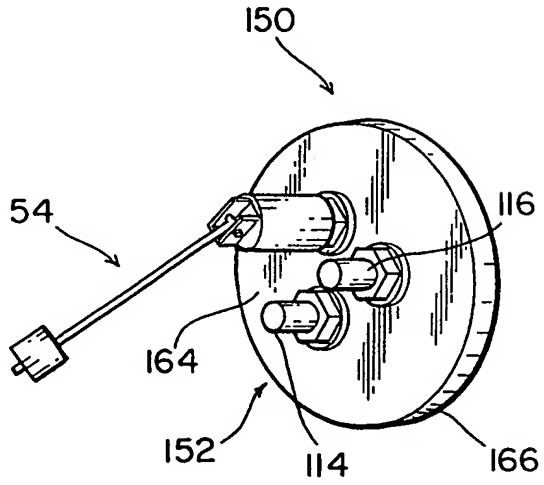

FIG. 7

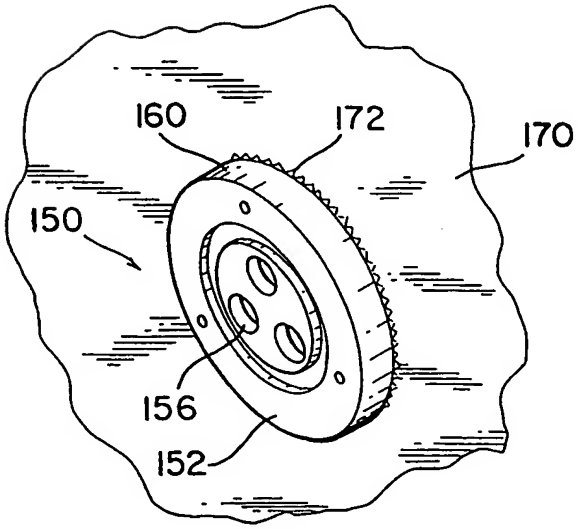

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/06998

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) : G01F 23/38; G01K 1/08, 13/00; H02H 5/04, 7/04
US CL :073/292; 374/152
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 073/292, 314, 317, dig. 5; 340/646; 361/035, 037; 374/142, 143, 152, 208, 210

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	FR 597,699 A (SPENGLER) 11 November 1925 (11/11/25), See the entire document.	1-20
A	US 2,311,387 A (HASTINGS) 16 February 1943 (16/02/43), See figure 2 and page 2, column 1 lines 17-19.	13, 18
Y	US 2,620,412 A (FORD) 02 December 1952 (02/12/52), See the entire document.	1-20
Y	US 2,686,300 A (BARR) 10 August 1954 (10/08/54), See figure 1 in particular.	1-20
Y	US 4,192,174 A (LOBERMANN ET AL) 11 MarchH 1980 (11/03/80), See the entire document.	1-20

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Date of the actual completion of the international search
15 JULY 1998

Date of mailing of the international search report
21 AUG 1998

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